证　明

CERTIFICATE

031500-16

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国 际 申 请 号: **PCT/CN03/00339**

INTERNATIONAL APPLICATION NUMBER

国 际 申 请 日: **12 MAY 2003(12.05.03)**

INTERNATILNAL FILING DATE

发 明 名 称: SYSTEM AND METHOD FOR EDGE BLENDING HARD DRIVE HEAD SLIDERS

TITLE OF INVENTION

中华人民共和国国家知识产权局局长

COMMISSIONER OF THE STATE INTELLECTUAL PROPERTY OFFECE OF THE PEOPLE'S REPUBLIC OF CHINA

王景川

二零零三年七月十五日

JULY 15, 2003

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REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

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International Application No. PCT/CN 03/ 0 0 3 3 9

International Filing Date 12 MAY 2003 (12.05.03)

RO/CN 中华人民共和国国家知识产权局 PCT International Application

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* FPEL03150016

Box No. I TITLE OF INVENTION

SYSTEM AND METHOD FOR EDGE BLENDING HARD DRIVE HEAD SLIDERS

Box No. II APPLICANT ☐ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

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This person is applicant for the purposes of: ☒ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

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Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

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This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

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State *(that is, country)* of nationality:

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- ☐ applicant and inventor
- ☒ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office:

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See Notes to the request form

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application:* regional Office	international application: receiving Office
item (1)				
item (2)				
item (3)				
item (4)				
item (5)				

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office)* identified above as:

☐ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ item (4) ☐ item (5) ☐ other, see Supplemental Box

** Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)):* ....

.....

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used)*:

ISA / CN .....

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority)*:

Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII DECLARATIONS

The following **declarations** are contained in Boxes Nos. VIII (i) to (v) *(mark the applicable check-boxes below and indicate in the right column the number of each type of declaration)*: Number of declarations

☐ Box No. VIII (i)	Declaration as to the identity of the inventor	:
☐ Box No. VIII (ii)	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	:
☐ Box No. VIII (iii)	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	:
☐ Box No. VIII (iv)	Declaration of inventorship (only for the purposes of the designation of the United States of America)	:
☐ Box No. VIII (v)	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	:

Sheet No. 5

Box No. IX CHECK LIST; LANGUAGE OF FILING

This international application contains:

(a) the following number of **sheets in paper form:**

request (including declaration sheets)	:	5
description (excluding sequence listing part)	:	6
claims	:	5
abstract	:	1
drawings	:	10
Sub-total number of sheets	:	27
sequence listing part of description *(actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (b) below)*	:	
Total number of sheets	:	27

(b) sequence listing part of description filed in **computer readable form**

(i) ☐ only (under Section 801(a)(i))

(ii) ☐ in addition to being filed in paper form (under Section 801(a)(ii))

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which the sequence listing part is contained *(additional copies to be indicated under item 9(ii), in right column)*: .....

This international application is **accompanied by** the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item)*:

		Number of items
1. ☒ fee calculation sheet	:	1
2. ☒ original separate power of attorney	:	1
3. ☐ original general power of attorney	:	
4. ☐ copy of general power of attorney; reference number, if any:	:	
5. ☐ statement explaining lack of signature	:	
6. ☐ priority document(s) identified in Box No. VI as item(s):	:	
7. ☐ translation of international application into *(language)*:	:	
8. ☐ separate indications concerning deposited microorganism or other biological material	:	
9. ☐ sequence listing in computer readable form (indicate also type and number of carriers (diskette, CD-ROM, CD-R or other))		
(i) ☐ copy submitted for the purposes of international search under Rule 13*ter* only (and not as part of the international application)	:	
(ii) ☐ *(only where check-box (b)(i) or (b)(ii) is marked in left column)* additional copies including, where applicable, the copy for the purposes of international search under Rule 13*ter*	:	
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10. ☐ other *(specify)*:	:	

Figure of the drawings which should accompany the abstract: FIG. 8

Language of filing of the international application: EN

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

CHINA PATENT AGENT (HONG KONG) LIMITED 中國專利代理(香港)有限公司 專利申請專用章

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1. Date of actual receipt of the purported international application: 12 MAY 2003 (12.05.03)

2. Drawings: ☐ received: ☐ not received:

3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:

4. Date of timely receipt of the required corrections under PCT Article 11(2):

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FEE CALCULATION SHEET
Annex to the Request

For receiving Office use only
International Application No. PCT/CN03/00339
Date stamp of the receiving Office 12 MAY 2003 (12.05.03)

Applicant's or agent's file reference: FPEL03150016

Applicant: SAE MAGNETICS (H.K.) LTD.

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE . . . . . CNY500 [T] — CNY500.-
2. SEARCH FEE . . . . . CNY1500 [S] — CNY1500.-
   International search to be carried out by _____
   (If two or more International Searching Authorities are competent to carry out the international search, indicate the name of the Authority which is chosen to carry out the international search.)
3. INTERNATIONAL FEE
   Basic Fee
   Where item (b) of Box No. IX applies, enter **Sub-total number of sheets**
   Where item (b) of Box No. IX does not apply, enter **Total number of sheets** } 27
   [b1] first 30 sheets . . . . . CHF650 [b1] — CHF650.-
   [b2] _____ (number of sheets in excess of 30) x _____ (fee per sheet) = _____ [b2]
   [b3] additional component (only if sequence listing part of description is filed in computer readable form under Section 801(a)(i), or both in that form and on paper, under Section 801(a)(ii)):
   400 x _____ (fee per sheet) = _____ [b3]
   Add amounts entered at b1, b2 and b3 and enter total at B . . . . CHF650 [B] — CHF650.-

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   The international application contains 1 designations.
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   (Applicants from certain States are entitled to a reduction of 75% of the international fee. Where the applicant is (or all applicants are) so entitled, the total to be entered at I is 25% of the sum of the amounts entered at B and D.)
4. FEE FOR PRIORITY DOCUMENT *(if applicable)* . . . . . [P] — CNY2000.-
5. TOTAL FEES PAYABLE . . . . . CNY2000CHF790 TOTAL — CHF790.-
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See Notes to the fee calculation sheet

SYSTEM AND METHOD FOR EDGE BLENDING HARD DRIVE HEAD SLIDERS

Background Information

[0001] The present invention relates to hard disk drives. More specifically, the invention relates to a system and method for edge blending hard drive head sliders.

[0002] **Figure 1** provides an illustration of a typical hard disk drive. Hard disk drive storage devices typically include a rotating disk 1 mounted for rotation by a spindle motor (not shown). A slider 3, supported by a suspension arm 5, 'flies' over the surface of the magnetic disk 1 at a high velocity, reading data from and writing data to concentric data tracks 11 on the disk 1. The slider 1 is positioned radially by a voice coil motor 7.

[0003] **Figure 2** shows a more detailed view of a head slider 3 flying over the surface of a magnetic disk 1 as is typical in the art. Modern head sliders 3 float over the surface of the disk 1 on a cushion of air. If the 'flying height' is too great, the head 12 on the head slider cannot properly read from and write to the disk 1. If it is too small, there is an increased chance of a head crash.

[0004] If a head slider 3 contacts the surface of the disk while it is at operational speed, the result can be a loss of data, damage to the head slider, damage to the surface of the disk 1, or all three. One of the most common causes of head crashes is a contaminant getting wedged in the microscopic gap between head 3 and disk 1. Head sliders 3 are typically ceramic for durability and corrosion resistance. A ceramic slider is durable due to its hardness. The tradeoff, however, of ceramic's hardness is its brittleness. When a row bar is cut into individual sliders 3 (explained below), the ceramic crystal array causes the slider 3 edges to crack easily. Loose chips of ceramic material may be found on the cutting surface edge corners even after solvent cleaning. Also, after cutting a row bar into individual sliders, a high point is often left on the cut slider surface. This is known as 'edge jump'. Edge jump is believed to be from the stress applied to the cut edge of the slider 3. A deformation layer is created by the

pressure 20 created by the cutting process. (*See* **Figure 3**).

[0005] **Figure 3** illustrates the problems related to particle contamination and edge jump as is typical in the art. The problems concerning loose chips 21 and edge jump 20 can cause hard drive head crashes. A loose chip 21 may fall from the slider and contaminate the interface between the slider 3 and disk 1. An edge jump 20 can affect a slider's anti-shock performance negatively. If the HDD gets a physical impact while operating, a location of edge jump may contact and damage the disk 1.

[0006] It is therefore desirable to have a system and method for edge blending hard drive head sliders, that avoids the above-mentioned problems, as well as having additional benefits.

Brief Description Of The Drawings

[0007] **Figure 1** provides an illustration of a typical hard disk drive.

[0008] **Figure 2** shows a more detailed view of a head slider flying over the surface of a magnetic disk as is typical in the art.

[0009] **Figure 3** illustrates the problems related to particle contamination and edge jump as is typical in the art.

[0010] **Figure 4** illustrates a head parting jig as is typical in the art.

[0011] **Figure 5** illustrates an edge blending jig according to an embodiment of the present invention.

[0012] **Figure 6** illustrates the attachment of a head blending jig to a head blending machine according to an embodiment of the present invention.

[0013] **Figure 7** illustrates portions of lapping tape inserted between individual head sliders mounted to an edge blending jig in a standby configuration and in two edge blending configurations according to an embodiment of the present invention.

[0014] **Figure 8** provides a more detailed illustration of lapping tape partially wrapping a slider's edge to perform edge blending according to an embodiment of the present invention.

[0015] **Figure 9** provides a detailed view of an individual slider mounted to an arm of an edge blending jig with lapping tape partially wrapping a slider edge for edge blending according to an embodiment of the present invention.

[0016] **Figure 10** illustrates an edge blending machine according to an embodiment of the present invention.

Detailed Description

[0017] **Figure 4** illustrates head parting jig as is typical in the art. As is illustrated in figure 4a, a slider row bar 401 is typically bonded to multiple arms 402 of a head parting jig 403. As is illustrated in figure 4b and described further below, the row bar is cut into individual head sliders 3 by a slider parting tool (not shown).

[0018] **Figure 5** illustrates an edge blending jig according to an embodiment of the present invention. As illustrated in **Figure 5a**, in one embodiment, a slider row bar 501 is bonded to multiple arms 502 of the edge blending jig, whereupon the row bar is separated into individual head sliders 3 by a slider parting tool (not shown). One advantage of this jig design is that imperfections on the edges of the sliders 3 (such as edge jump) can be detected by viewing the sliders from behind 505 and observing the uniformity of gaps between the sliders 3.

[0019] **Figure 6** illustrates the attachment of a head blending jig to a head blending machine according to an embodiment of the present invention. In one embodiment, the edge blending jig is coupled to a support assembly 12 of the head blending machine by a pair of pins 11.

[0020] **Figure 7** illustrates portions of lapping tape inserted between individual head sliders mounted to an edge blending jig in a 'standby' configuration and in two edge blending configurations according to an embodiment of the present invention. As illustrated in figure 7a, in one embodiment, lapping tape 701 covered with an abrasive, such as diamond powder (*e.g.*, of a grade between 0.1 microns and 3.0 microns), is inserted between sliders 3. **Figure 7a** shows the edge blending assembly in a 'standby' configuration with the sliders 3 out of contact with the lapping tape 701. **Figure 7b** shows the edge blending assembly configured to partially wrap the lapping tape 701 across one of the edges of each slider 3 on the edge blending jig 2 according to an embodiment of the present invention. In this embodiment, the lapping tape is positioned by an adjustable series of rollers (described below) to be stretched across the slider edges at a predetermined tension force (*e.g.*, less than 0.8 kilograms). In this embodiment, the edge blending jig 2 is directionally oscillated 712 by the edge

blending assembly to cause relative motion between the sliders 3 and the lapping tape 701 (*e.g.*, at a frequency of at least 1 cycle per second and at an amplitude between 10 millimeters and 40 millimeters). **Figure 7c** shows the edge blending assembly configured to partially wrap the lapping tape 701 across the opposite edge of each slider 3 according to an embodiment of the present invention. In this embodiment, the edge blending assembly is configured to stretch the lapping tape 701 across the opposite edge of each slider to complete the edge blending process. As explained below, in one embodiment, the process of edge blending is performed submerged in lubricant.

[0021] **Figure 8** provides a more detailed illustration of lapping tape partially wrapping a slider's edge to perform edge blending according to an embodiment of the present invention. In one embodiment, a first angle (α) is formed between a face 805 of the slider 3 and the lapping tape 801, and a second angle (β) is formed between the opposite face 806 of the slider 3 and the lapping tape 801 (α. and β being between 3 degrees and 90 degrees, for example).

[0022] **Figure 9** provides a detailed view of an individual slider mounted to an arm of an edge blending jig with lapping tape partially wrapping a slider edge for edge blending according to an embodiment of the present invention. In one embodiment, after a row bar is bonded to multiple arms of an edge blending jig 2 (by, *e.g.*, epoxy) and cut into individual mounted sliders 3 (such as by a diamond cutting wheel), lapping tape 1 is inserted between the sliders 3 and the edge blending assembly is configured to wrap the lapping tape 1 around an edge of the slider 3 under a predetermined amount of tensile force. As stated above, in this embodiment, the slider 3 is directionally oscillated to achieve relative motion between the slider 3 and the lapping tape 1.

[0023] **Figure 10** illustrates an edge blending machine according to an embodiment of the present invention. In one embodiment, an edge blending jig with mounted sliders is coupled to a jig support 5 and mounted in the edge blending machine. In this embodiment, a top platform 4, containing lapping tape rollers 16, is attached to a base unit 9, supporting the edge blending jig. In this embodiment, portions of lap tape 1001 are positioned and kept in alignment by a series of guide arms 17. In this embodiment

a spring mechanism 6, which is adjusted by a tension adjustment knob 1002, is utilized to maintain the appropriate tensile force for the portions of lapping tape 1001. Maintaining appropriate lapping tape tension is important to prevent lapping tape 1001 breakage or dislodging of sliders from the edge blending jig arms.

[0024] In this embodiment, another adjustment knob 1003 is utilized to move the lapping tape portions relative to the sliders (on the edge blending jig) to shift the relative position to partially wrap the slider edges appropriately (to provide the appropriate angles of α. and β). In this embodiment, the process of edge blending is performed with the edge blending assembly submerged in lubricant. In this embodiment, a reservoir 7 is filled above the level of the sliders with a lubricant (such as a mixture of de-ionized (DI) water and oil) before edge blending.

[0025] In one embodiment, rubber tape is used instead of the lapping tape with the reservoir 7 filled with a diamond slurry. In this embodiment, the diamond particles travel on the rubber tape as an abrasive to smooth the slider edge's surface. Also, in an embodiment, a cleaning process could be performed after edge blending, wherein the lapping tape 1001 is replaced with rubber tape and the reservoir 7 is filled with a cleaning solution. The slider would be oscillated with respect to the rubber tape in the cleaning solution to clean any debris left on the sliders after the edge blending process.

[0026] Although several embodiments are specifically illustrated and described herein, it will be appreciated that modifications and variations of the present invention are covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

What is Claimed is

1. A system for manufacturing a hard disk drive head slider comprising:

an edge blending jig of an edge blending assembly to bond to a number of head sliders for edge blending, said edge blending by lapping tape, wherein

said edge blending jig is configured to receive a portion of lapping tape between each of a number of said sliders;

said edge blending jig is configured to allow said lapping tape to partially wrap an edge of each slider; and

said edge blending is performed by relative movement between said sliders and said lapping tape.

2. The system of claim 1, wherein said edge blending is by directional oscillation of said sliders with respect to said lapping tape.

3. The system of claim 2, wherein said oscillation of the sliders is at a frequency of at least 1 cycle per second.

4. The system of claim 2, wherein said oscillation of the sliders is at an amplitude of at least 10 millimeters.

5. The system of claim 2, wherein said slider oscillation is performed with a first angle (α) between a first face of the slider and the lapping tape and with a second angle (β) between a second face of the slider and the lapping tape, said first angle and said second angle each being between 3 degrees and 90 degrees.

6. The system of claim 2, wherein said slider oscillation is performed with a portion of lapping tape partially wrapped around an edge of each slider under a tension force of at least 0.05 kilograms.

7. The system of claim 2, wherein said edge blending is performed with said sliders and said lapping tape submerged in a lubricant.

8. The system of claim 2, wherein said lapping tape has a lapping surface covered with an inorganic powder.

9. The system of claim 8, wherein said inorganic powder is diamond powder.

10. The system of claim 8, wherein said powder has a grade between 0.1 microns and 3.0 microns.

11. The system of claim 2, wherein said lapping tape has a thickness between 40 microns and 100 microns.

12. The system of claim 2, wherein said lapping tape is greater than 1.2 millimeters in width.

13. The system of claim 2, wherein a slider row bar is to be bonded to said edge blending jig, said row bar to be separated into individual head sliders upon the edge blending jig.

14. The system of claim 13, wherein said row bar is to be separated into individual sliders by a diamond cutting wheel.

15. The system of claim 2, wherein for a slider cleaning process said lapping tape is a rubber tape and said oscillation is performed with said sliders and said rubber tape submerged in a cleaning solution.

16. The system of claim 15, wherein said cleaning process is performed for at least 30

seconds.

17. The system of claim 2, wherein said lapping tape is a rubber tape and said oscillation is performed with said sliders and said rubber tape submerged in a diamond slurry.

18. A method for manufacturing a hard disk drive head slider comprising:

inserting lapping tape between each of a number of head sliders bonded to a edge blending jig of an edge blending assembly;

adjusting said edge blending assembly to cause the lapping tape to partially wrap an edge of each slider; and

edge blending said head sliders by relative movement between said sliders and said lapping tape.

19. The method of claim 18, wherein said edge blending is by directional oscillation of said sliders with respect to said lapping tape.

20. The method of claim 19, wherein said oscillation of the sliders is at a frequency of at least 1 cycle per second and an amplitude of at least 10 millimeters.

21. The method of claim 19, wherein said slider oscillation is performed with a first angle (α) between a first face of the slider and the lapping tape and with a second angle (β) between a second face of the slider and the lapping tape, said first angle and said second angle each being between 3 degrees and 90 degrees.

22. The method of claim 19, wherein said slider oscillation is performed with a portion of lapping tape partially wrapped around an edge of each slider under a tension force of at least 0.05 kilograms.

23. The method of claim 19, wherein said edge blending is performed with said sliders and said lapping tape submerged in a lubricant.

24. The method of claim 19, wherein said lapping tape has a lapping surface covered with a diamond powder having a grade between 0.1 microns and 3.0 microns.

25. The method of claim 19, wherein said lapping tape has a thickness between 40 microns and 100 microns.

26. The method of claim 19, further comprising:

bonding a head slider row bar to said edge blending jig; and

separating said row bar into said number of head sliders.

27. The method of claim 26, wherein said separating said row bar is performed by a slider parting tool.

28. The method of claim 19, wherein for a slider cleaning process said lapping tape is a rubber tape and said oscillation is performed with said sliders and said rubber tape submerged in a cleaning solution.

29. The method of claim 28, wherein said cleaning process is performed for at least 30 seconds.

30. The method of claim 19, wherein said lapping tape is a rubber tape and said oscillation is performed with said sliders and said rubber tape submerged in a diamond slurry.

31. A method for manufacturing a hard disk drive head slider comprising:

bonding a head slider row bar to a edge blending jig of an edge blending assembly;

separating upon the edge blending jig the row bar into a number of head sliders;

inserting lapping tape between each slider on the edge blending jig;

adjusting said edge blending assembly to cause the lapping tape to partially wrap an edge of each slider; and

edge blending said head sliders by motion oscillation of said sliders with respect to said lapping tape.

Abstract

A system and method are disclosed for edge blending hard drive head sliders by oscillating abrasive lapping tape across the edges of multiple sliders simultaneously.

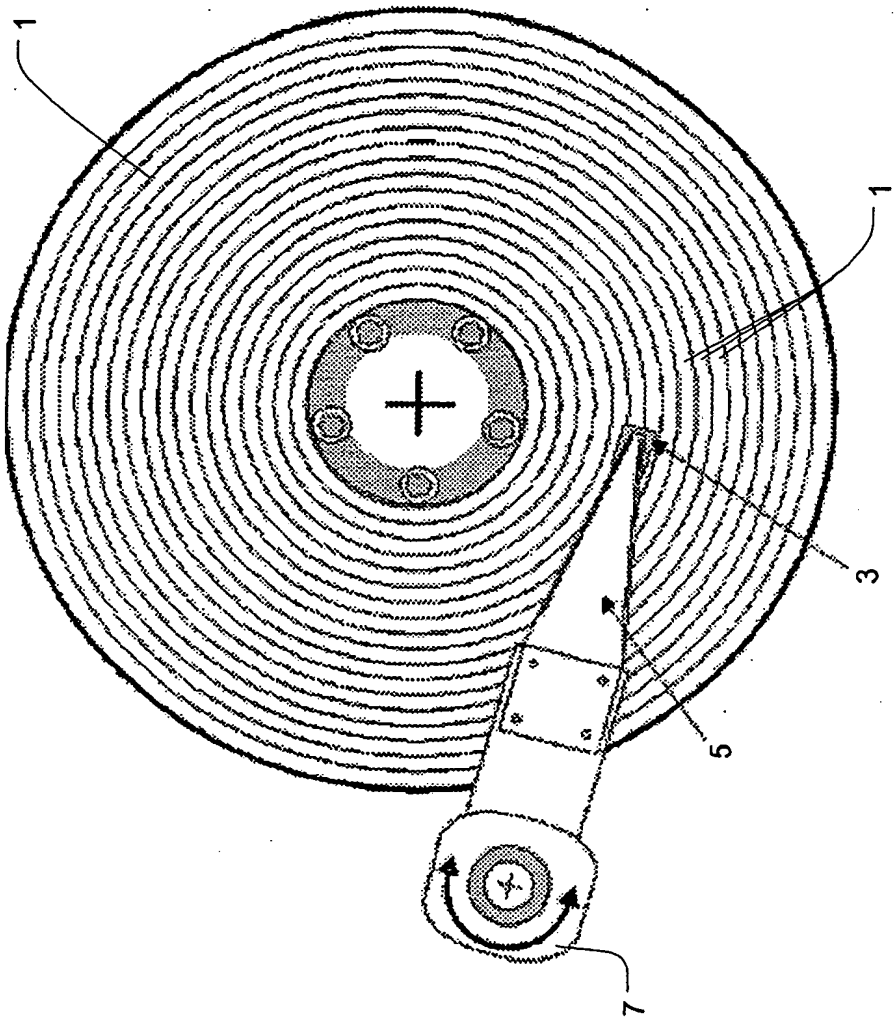

FIG. 1
(Prior Art)

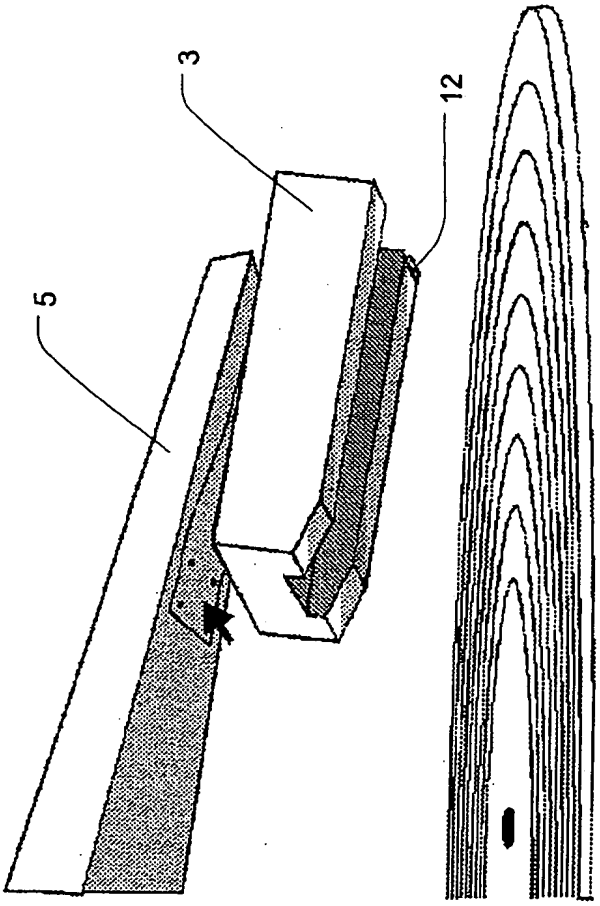

FIG. 2
(Prior Art)

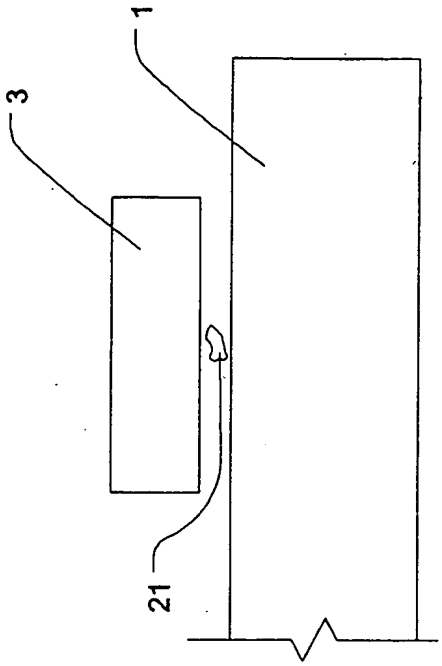

FIG. 3b

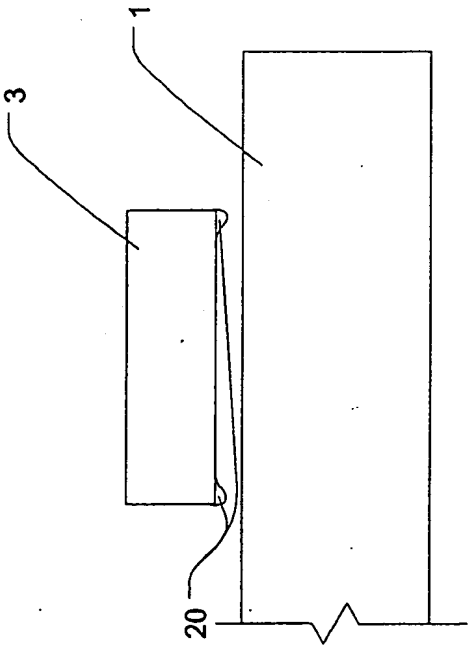

FIG. 3a

FIG. 3
(Prior Art)

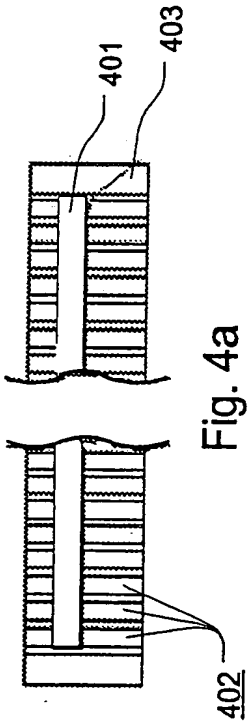

Fig. 4a

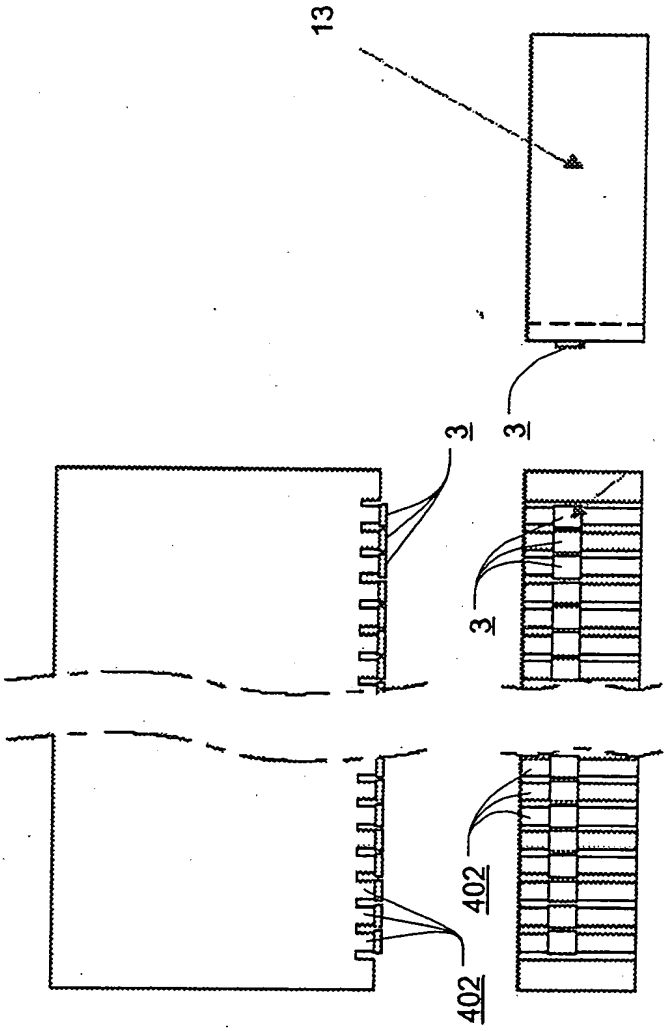

Fig. 4b

FIG. 4

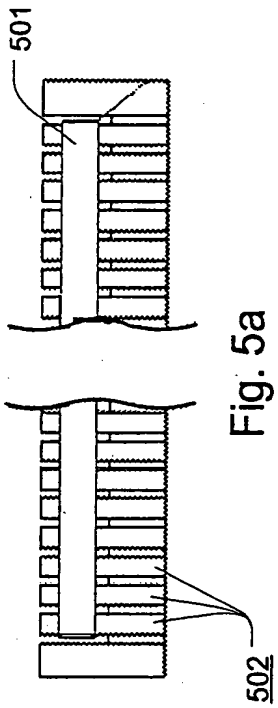

Fig. 5a

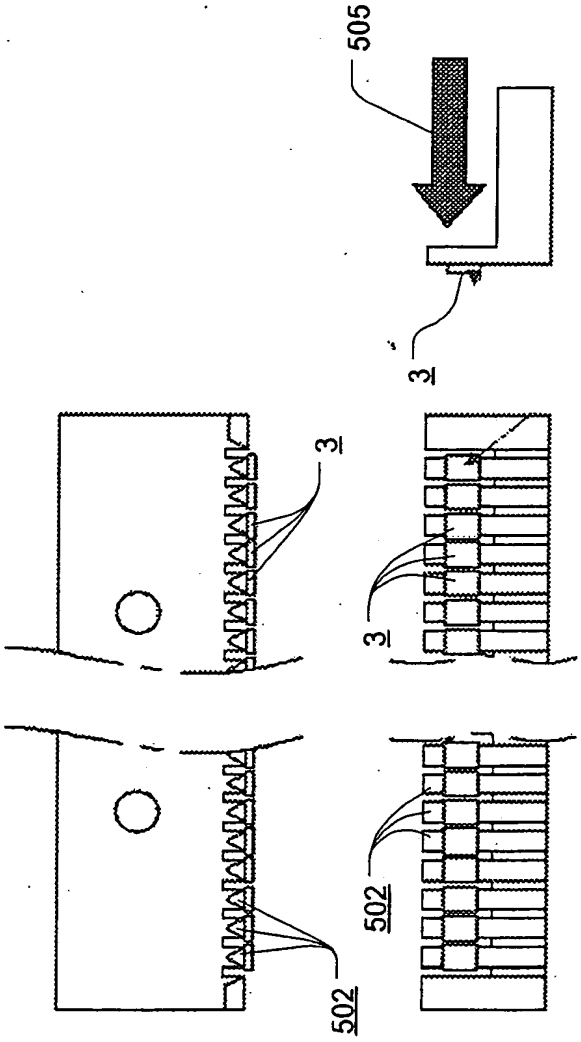

Fig. 5b

FIG. 5

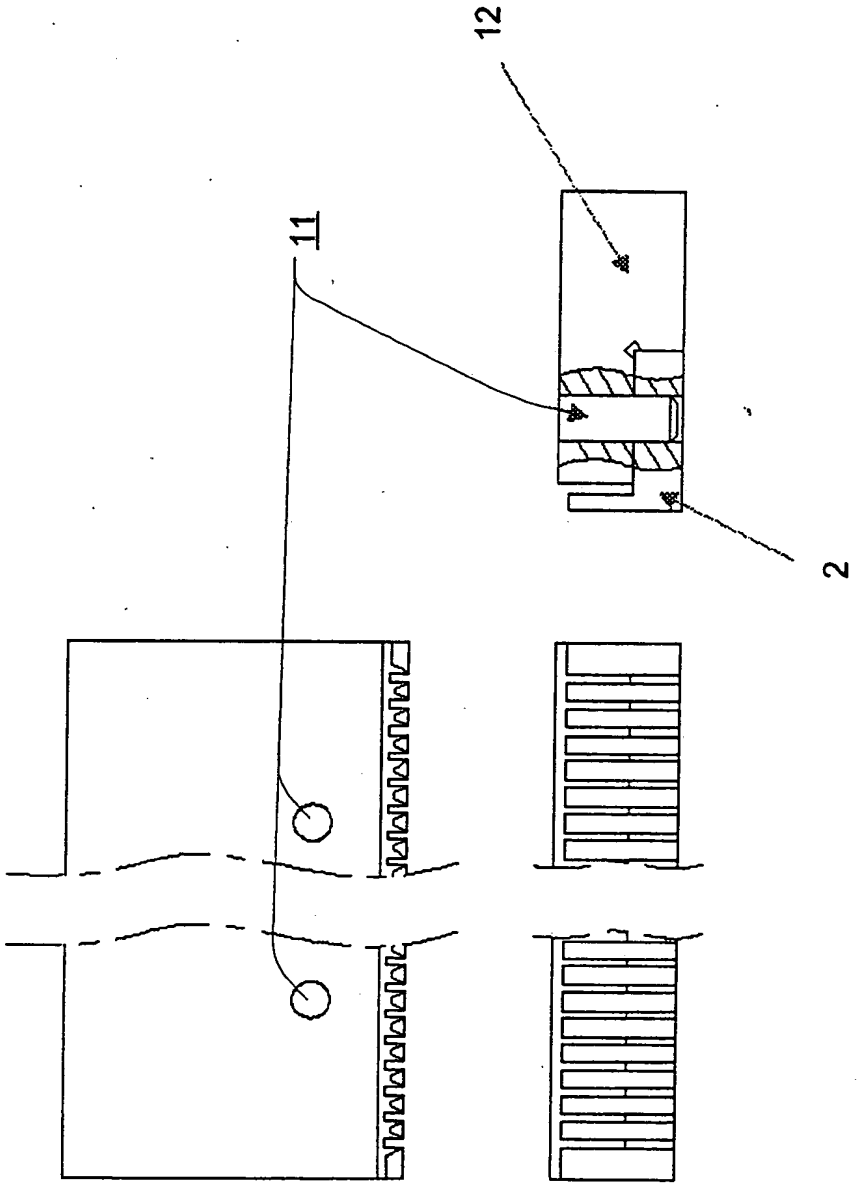

FIG. 6

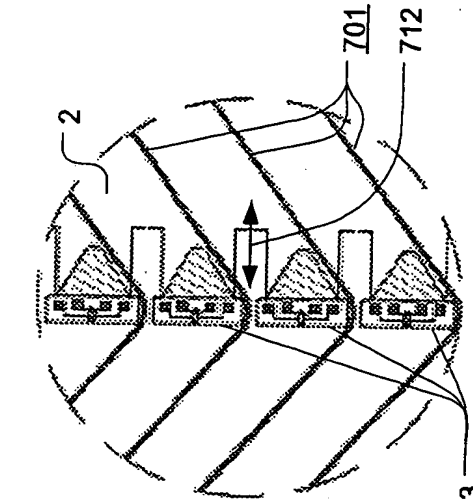

Fig. 7c

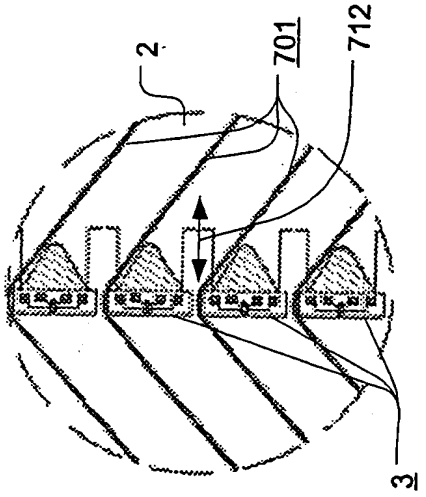

Fig. 7b

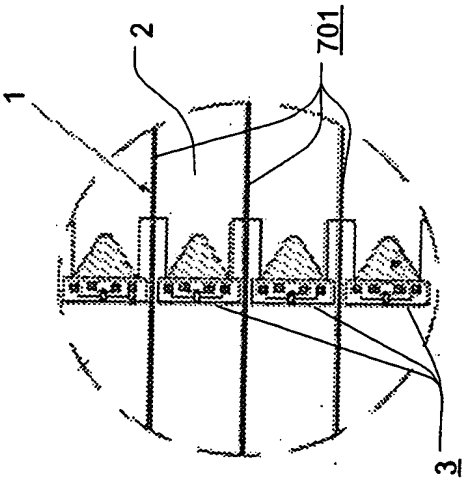

Fig. 7a

FIG. 7

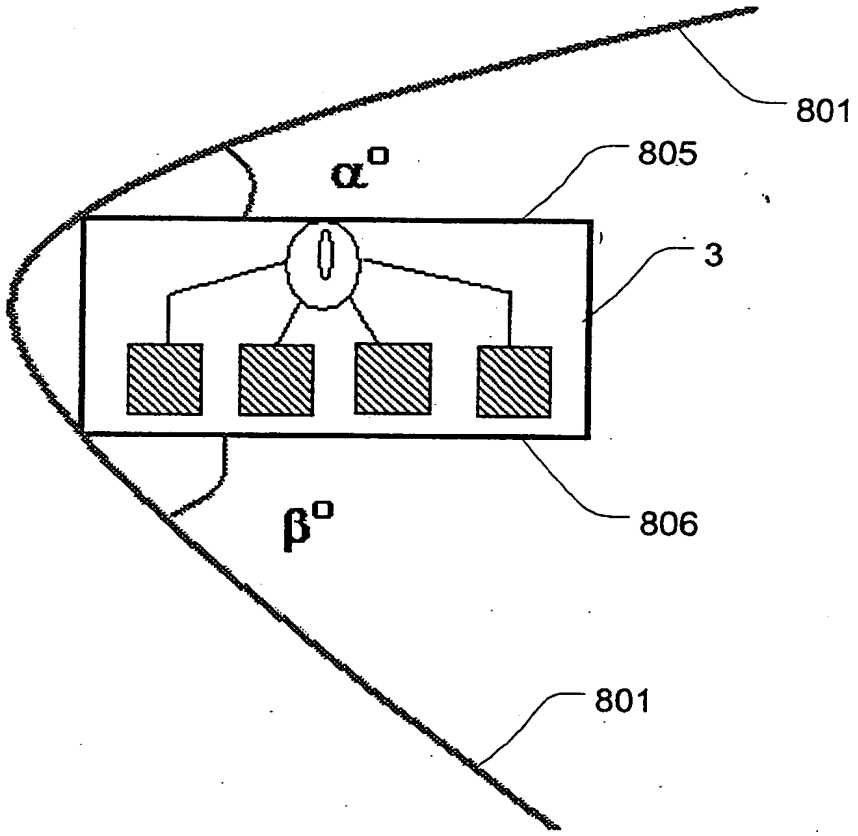

FIG. 8

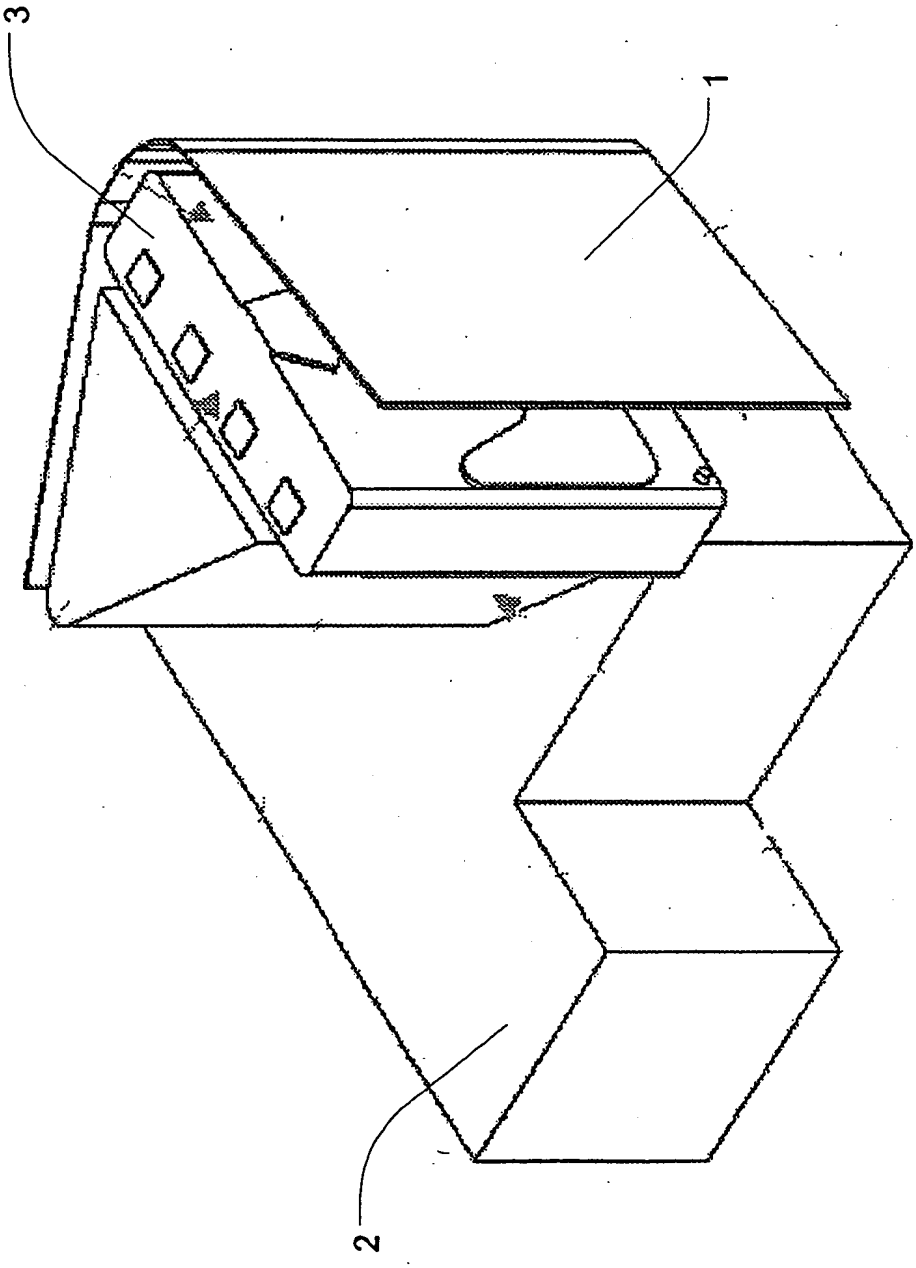

FIG. 9

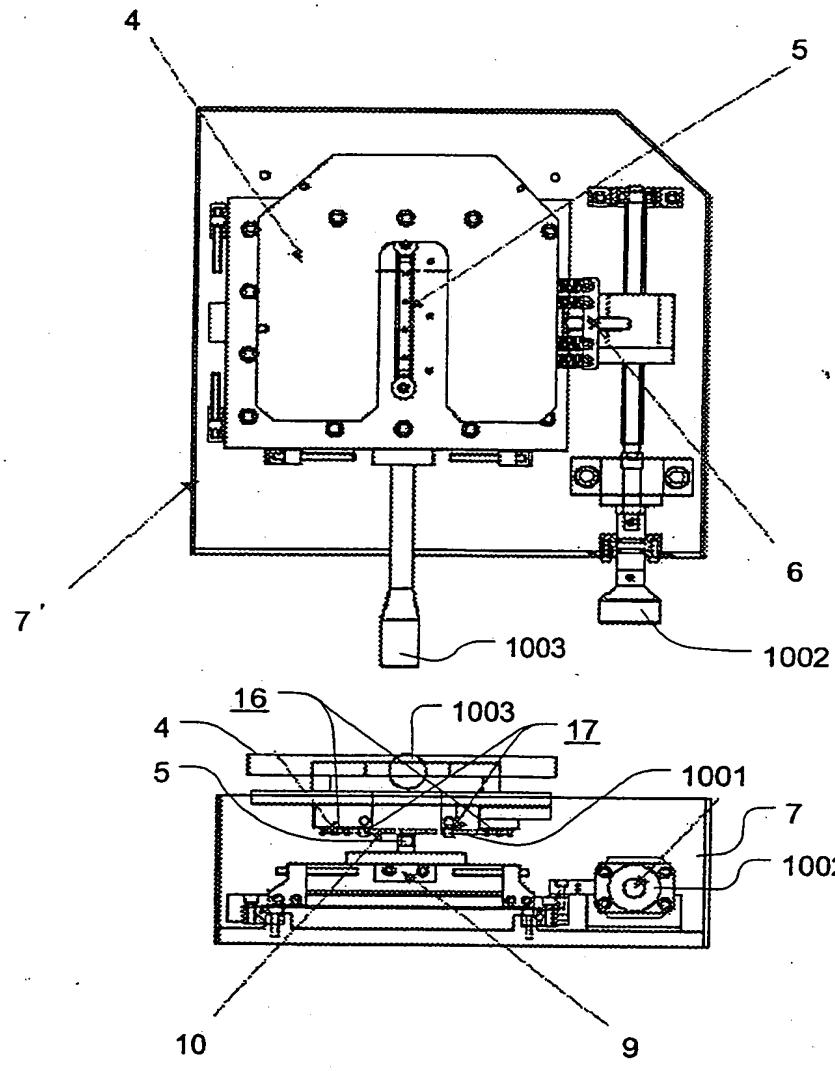
4
5
6
7
1003
1002
Top View
16
1003
17
4
5
1001
7
1002
Front View
10
9

FIG. 10